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CARUNCULATE SEED DISSEMINATION BY ANTS

BURTON N. GATES

THE caruncle-bearing seeds of the Large White Trillium and of the Bloodroot, have been shown to be disseminated by ants.[1] They are attracted by the caruncle, as a lure and a probable source of food. It was observed that the seeds were carried into the ants' nest, the caruncle removed, and the denuded seeds discarded outside of the nest. This the writer reported in RHODORA.

[1] Burton N. Gates, Dissemination by Ants of the Seed of *Trillium grandiflorum.* RHODORA, 1940. vol. 42, p. 194.

Ibid. Observations in 1940 on the Dissemination by Ants of the Seeds of *Trillium grandiflorum.* RHODORA, 1941, vol. 43, p. 206.

Ibid. Dissemination by Ants of the Seeds of Bloodroot, *Sanguinaria canadensis.* RHODORA, 1942, vol. 44, p. 13.

From these observations, it was anticipated that other caruncle-bearing seeds, likewise attract ants as a food source and are ant-dispersed. By examining many kinds of seeds, a few were found with a caruncle. These were tested with ants for their reactions. The same general methods have been employed, as with the Trillium and the Bloodroot. All seeds were freshly gathered and handled with forceps to minimize contamination with foreign odors. These experiments were made at Worcester, Massachusetts.

Ricinus species

The Castor bean, *Ricinus sp.*, an exotic plant is generally known to have a huge caruncle. This foreign seed, it might be anticipated, would have no attraction for New England, common ant-species. Its habitat is considered to be Africa; possibly it is indigenous to tropical America and Asia. It is grown in the north-temperate zone for ornament, though not extensively. With it, our native ants can have had little more than a limited and recent experience. It is popularly thought to have properties repellent or perhaps poisonous to insects and animals. Beans placed in the tunnel of a mole are said to be repellent and poisonous. While gathering freshly ripened beans, a gardener told the writer, "ants never go near the Castor bean plants."

As a test, freshly collected beans were offered to various, undetermined ants on October 4, 1941, at several stations. Although the ant reactions were not absolutely negative, for a time it appeared that this carunculate seed might prove unattractive. Seemingly indifferent, some ants were seen to explore the seed and to tap the bean and caruncle with their antennae. To further test this slight reaction, and, because the seed is so mountainous as compared with the size of most of our common ants, the caruncle was removed and offered separately. This resulted in increased activity, but there was no apparent effort to carry off the caruncle. Finally, the hard, fibrous caruncle was crushed and broken with forceps. A trial piece brought immediate response; an ant carried away the first piece offered. Crushing doubtless expressed or released some of the oils which are thought to be the food elements in the caruncle which attract the ants. In succeeding trials, each ant which carried off a

piece of caruncle was caught for identification. The nine collected ants proved to be of one species, *Prenolopis imparis* Say.[1]

The reaction of the New England ants to the tropical Castor bean caruncle would indicate that in its native habitat, it too is a lure to ants in the dissemination of the seeds. It is the usual practice for an ant to carry the seed to the nest with the attached caruncle. Due to the disproportionate size of our ants to the greater bulk and weight of the seed of the Castor bean, the predominately small ant species, commonly found in this locality could hardly be expected to attempt this feat. On this feature Mr. Wesson commented in a letter, that in the tropics, where there is a wealth of ant species, "there would be many strong enough to transport this bean." He also ventured that in our northeastern States "this bean could be transported, although not with facility, by some members of the genera *Formica* and *Camponotus*". Although not yet demonstrated, it would appear from the ant reactions that the beans of the Castor bean plant in their natural habitat, doubtless may be disseminated by ants.

Viola

Various species of *Viola* seeds were found to be carunculate. Cleistogamous seeds of *Viola cucullata* Ait. on October 5, 1941 were ripening freely. During the warm part of the day, ants were working in and out of their nests. At the first station in a dirt path, where an experiment with these seeds was attempted, it was a surprise to find that the ants of this nest had already gathered violet seeds (doubtless *V. cucullata*). Resting lightly on the sandgrain cone of the entrance, apparently having been cast from the nest within the last few hours, twenty-four *Viola* seeds were picked up with the forceps. The caruncle of each seed had been gnawed off, a confirmation of ant behavior as determined in the early experiments with Trillium seeds. Three specimens of the ants of this nest, which had ejected the *Viola* seeds were identified by Mr. Wesson as *Lasius americanus*.

At a second station freshly gathered *Viola* seeds were placed adjacent to a small entrance. The head of an entrance-guard could be seen, practically closing the hole. As if by magic, the seeds disappeared into the nest, one by one. The guard was seen

[1] Mr. Lawrence G. Wesson, Jr., Boston, Massachusetts has generously made ant determinations in all of these experiments. His assistance is appreciated.

to emerge slightly, pick up a seed and disappear so quickly with it, that she virtually defied detection. Nine seeds were hastily taken in this way; the tenth was stolen and carried off by a strange ant. She was traced to her entrance, about two feet away, into which she disappeared with the seed. Two specimens from this nest were identified by Mr. Wesson as *Prenolopis imparis*.

Chelidonium majus

Celandine, *Chelidonium majus* L., was found on June 13, 1942 to be ripening seeds which were carunculate. They are small, about 1 mm. the long way. At the first station, seeds were shelled from a pod on to a flat stepping-stone where ants were crossing. The seeds at first attracted little attention; one small ant picked up the same seed on two occasions, carried it a short distance and dropped it. This hesitation was also observed on several occasions in the course of the trials. A slightly larger ant found the seeds and carried away eight of them in quick succession. Apparently, this was done by the same individual, judging from her searching behavior and her haste to find more seeds. No identification of the ant species was attempted in these tests with the Celandine seeds, the behavior being so uniform with that of the various species identified by Mr. Wesson.

At the second station, four seeds were promptly picked up from the dirt path. Seven to ten ants when offered a slightly opened pod placed on the ground, endeavored to extract seeds through the opening. At the third station, a pod which had been partially split open was placed on a path. Several ants of a larger species attacked it, forcing their way into and enlarging the cleft. In a brief period, ten seeds were removed and carried a short distance to the nest.

Referring to the first trials with Celandine seeds, several ants were observed to hesitate, as if to examine the seed which they had clutched. In some instances the seed was dropped and picked up again by the returning ant. Usually, it was carried away after a more or less extended examination. While no positive interpretation seemed possible, this behavior suggests either an unfamiliar food material, requiring some sort of determination by the ant, or an undetected attempt to remove the caruncle in the field. There is evidence of a process of

learning or becoming acquainted with a new and satisfactory food. Having recognized the good food, there appears to be a means of announcing the "find." The first Celandine seeds taken into the nest noticeably increased the nest activity at the entrance. Excitement was evident as ants hurried out in increased numbers, quite comparable to a recognized behavior of honeybees. It has been demonstrated that bees have a means of announcing a new "find" to the other workers in the hive, which results in increased hive-activity and a rush from the entrance. The ant behavior was quite comparable, as soon as the first few Celandine seed passed into the nest; excitement around the entrance was manifest. More and more ants emerged; more and more ants attempted to force their way into the split in the Celandine pod, removing seeds about as fast as they could be counted. By some means, the "find" of a quantity of Celandine seeds had become known quickly, to many workers.

DICENTRA SPECTABILIS

Bleeding Heart, *Dicentra spectabilis* Lem. (sometimes called *Dielytra spectabilis* in horticulture), self-sows widely in the writer's garden, suggesting to Mrs. Gates that this plant, like *Viola* and some weedy species might be disseminated by ants. She confirmed this August 30, 1942. The seeds are a glistening, polished black having a proportionately large "crest", as termed in Gray's Manual of Botany. The first seed which Mrs. Gates offered an ant was instantly taken; simultaneously, one she had placed on a stepping-stone disappeared. She fed various ants a pod of five seeds within a few minutes. All were readily accepted. The only other pods which could be found were not quite ripe. Slightly unripe seeds, lacking the lure, which may be odor, flavor, consistency, immaturity of the caruncle or some other quality, have no attraction for ants. This also has been observed with other species of seeds, in particular with Celandine seeds. August 31 a ripe pod was found. The seeds were offered to ants at a number of different stations. Because of the shortage of seeds at this late season, a few of them were recovered and used in more than one trial. Three positive reactions, each at a different station, were immediately obtained. At one station, an ant climbed into the match box in which the seeds were being carried,

stole a seed and made away with it before she could be captured. A series of seven positive reactions were then obtained; the fourth subject, however behaved unusually. This ant spent considerable time in an apparent effort to remove the carunculate "crest". She finally gave up the task and carried away the whole seed. Should this become a usual practice in the field, obviously, the primary function of the caruncle to bring about seed dispersal would be defeated. On the contrary, among the many observations, practically every ant appeared to be impelled to pick up the seed and carry it away in the greatest haste.

Summary

In mentioning the caruncle, the fact that a seed may have a minute, not visible caruncle has been disregarded. For the purpose of these experiments, a carunculate seed has a pronounced caruncle, visible and presumed to be ant food. In the search for carunculate seeds, all kinds of seeds have been examined. This has been necessitated, because the caruncle is seldom mentioned or indicated in taxonomic keys, as Gray's Manual. It appears possible, however, that seed characters, including the caruncle could be used to advantage in plant classification. For instance, the seeds of all Violas (no mention in Gray) thus far examined are carunculate: these caruncles and seeds appear to differ with the species and may be of taxonomic value.

In order to bring together and visualize these findings, a list of the seeds observed with a pronounced caruncle or aril, as well as those mentioned by Gray or elsewhere has been arranged; seeds used in the experiments with ants are indicated by an asterisk(*).

Family	Carunculate Trend	Species observed with Caruncle
Liliaceae	Verious genera with caruncle and aril	**Trillium grandiflorum* (Michx.) Salisb.
Nymphaeaceae	Ariled seeds in genus *Castalia*	
Anonaceae	Ariled	
Berberidaceae	With and without aril	

FAMILY	CARUNCULATE TREND	SPECIES OBSERVED WITH CARUNCLE
Papaveraceae	Many species with caruncle or crest	**Sanguinaria canadensis* L. **Chelidonium majus* L. *Macleaya cordata* (Willd.) R. Br.
Fumariaceae	Genera and species vary with and without crest, caruncle or aril: factors used in classification	**Dicentra spectabilis* Lem.
Polygalaceae	Species largely caruncu-late: used in classification	
Euphorbiaceae	Various genera and species with caruncle; used in classification	**Ricinus* sp. (probably *communis*)
Celastraceae	Mostly ariled	
Violaceae	Not mentioned in Gray's Manual (Seventh ed.) as carunculate. Caruncu-late seeds of *Viola blanda, incognita,* and *renifolia* are illus-trated in Baird—Wild Violets of North America, Berkeley, 1942, p. 160, but no mention is made in the text of the caruncle.	*Viola pedata* L. **cucullata* Ait. " forms, (two white-flowered forms in cultivation) *palmata* L. *fimbriatula* Sm. *lanceolata* L. *pallens* (Banks) Brainerd *blanda* Willd. *incognita* Brainerd *renifolia* Gray *odorata* L. (A single, white form with violet markings; fragrant) *pubescens* Ait. *tricolor* L. (Cultivated pansy) *tricolor* L. ("Johnny-Jump-up") *arvensis* Murr. "Jersey Gem", a horticultural variety

ANT SPECIES AND THE SPECIES OF CARUNCULATE SEEDS TO WHICH ANTS REACTED

During the tests covering several years, eight species of ants have responded to the caruncle of six species of seeds. As will be observed in the tabulation, a given species of ant reacted to one or to more than one species of seed. Since the tests were made at random, there is no indication that an ant species selected or

refused any particular species of seed. Instead, had it been possible to make the tests, it is not unlikely that the various ants would have responded to any of the various caruncles. It is likewise presumable that other ant species and other carunculate seeds would give comparable results.

Ants	Plants with Carunculate Seeds to which Ants reacted
Camponotus herculeanus pennsylvanicus	*Trillium grandiflorum* (Michx.) Salisb.
Formica fusca subsericea	*T. grandiflorum*
Formica neogagates var.	*T. grandiflorum, Sanguinaria canadensis* L.
Lasius americanus	*S. canadensis, Viola cucullata* Ait.
Lasius niger var. *americanus*	*T. grandiflorum*
Myrmica emeryana	*S. canadensis*
Myrmica fracticornis	*T. grandiflorum*
Prenolepis imparis	*Ricinus* species, *V. cucullata*

Observations thus far indicate that carunculate seeds are for the most part of the drop-seed type, *Viola* being an exception. (The mechanical dispersal in *Viola* is accomplished by means of the lengthwise closing of the valves of the capsule, as it opens and dries, ejecting the seeds. Ants may carry them a much greater distance, accomplishing wider dispersal.) Dissemination by ants, in the New England flora, has proven more general than was at first thought, when tests with *Trillium* seeds were made. The interrelation of ants and of carunculate seeds may be even more widespread than is now presumed. In general, ants and carunculate seeds may be interdependent: this, in fact, may be cosmopolitan.

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VIRGINIAN BOTANIZING UNDER RESTRICTIONS

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(*Continued from page 413*)

Tiarella Wherryi Lakela in Am. Journ. Bot. xxiv. 344, pl. 1 (1937), including *T. cordifolia*, var. *collina* Wherry, Not. Nat. Acad. Sci. Phil. no. 42: 3 (1940) and *T. cordifolia*, subsp. *collina* (Wherry) Wherry, l. c. 4 (1940). To the counties already recorded (Amelia, Mecklenburg, Henry and James City) add the following. Bedford County: May 7, 1871, *A. H. Curtiss.*